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(54) **PORTABLE ELECTRONIC DEVICE AND METHOD OPERATING SAME**

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(51) **Int. Cl.**

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G06F 1/16	(2006.01)
G06F 3/0484	(2013.01)
G06F 3/0346	(2013.01)

(52) **U.S. Cl.**

CPC ***G06F 1/1643*** (2013.01); ***G06F 3/0346*** (2013.01); ***G06F 3/0484*** (2013.01)

(58) **Field of Classification Search**

CPC G06F 3/01; G06F 3/041; G06F 3/042; G06F 3/0425

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0200802 A1*	8/2012	Large	.....	G02B 6/0046 349/62
2013/0181896 A1*	7/2013	Gruhlke	.....	G06F 3/017 345/156

* cited by examiner

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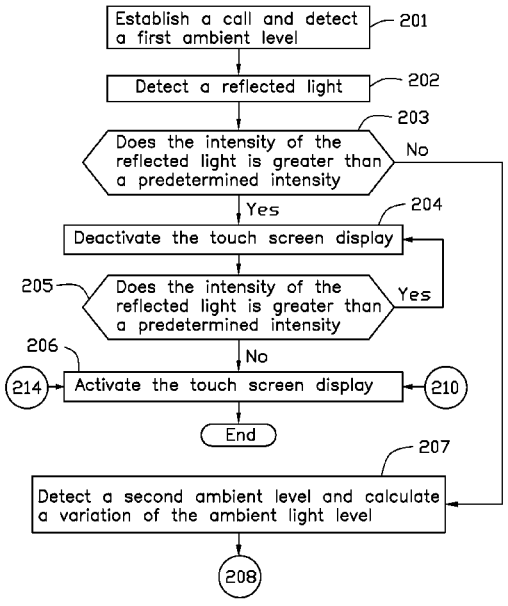
(57) **ABSTRACT**

A portable electronic device includes a touch screen display, a proximity sensor, an ambient light sensor, and a controller. The proximity sensor detects and outputs an intensity of the reflected light. The ambient light sensor detects and outputs a variation of an ambient light level of the portable electronic device. The controller deactivates the touch screen display when it is determined by the controller that the intensity of the reflected light is greater than a predetermined intensity, and determines whether the variation of the ambient light level is greater than a predetermined level when it is determined by the controller that the intensity of the reflected light is less than the predetermined intensity. The controller further deactivates the touch screen display when it is determined by the controller that the variation of the ambient light level is greater than the predetermined level.

8 Claims, 5 Drawing Sheets



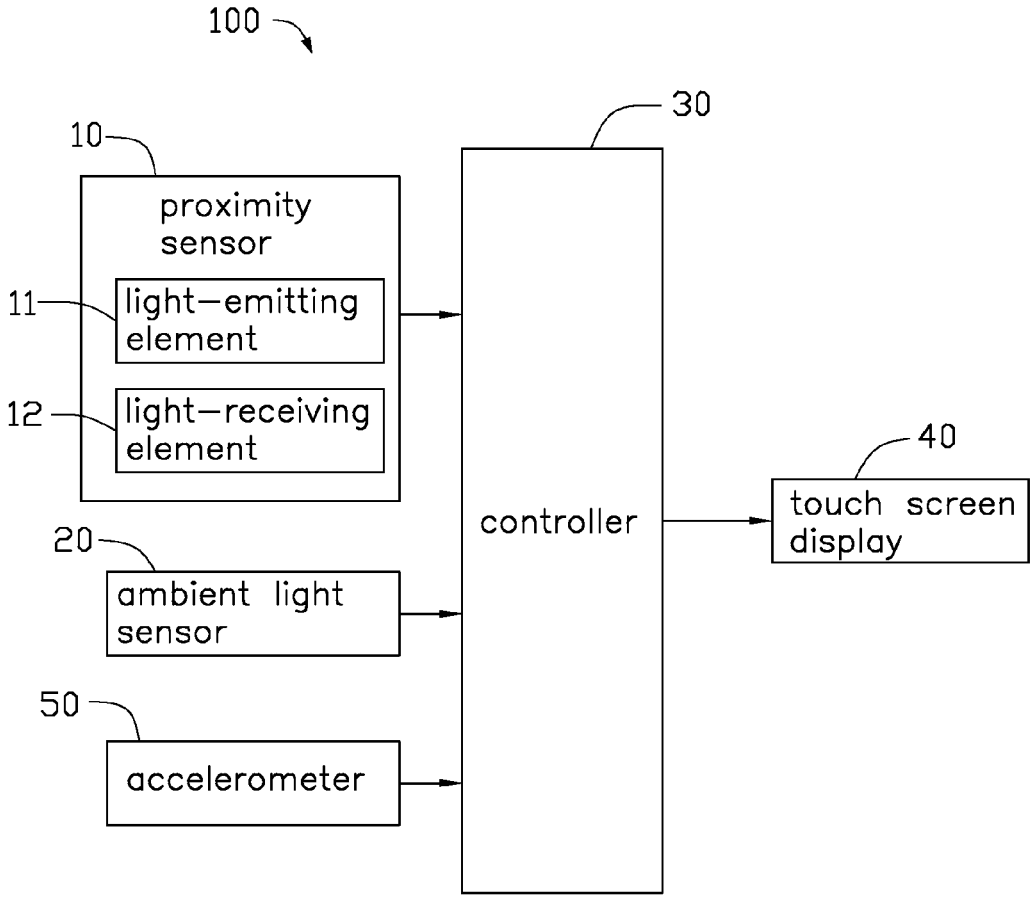

100
10
proximity sensor
11
light-emitting element
12
light-receiving element
20
ambient light sensor
50
accelerometer
30
controller
40
touch screen display

FIG. 1

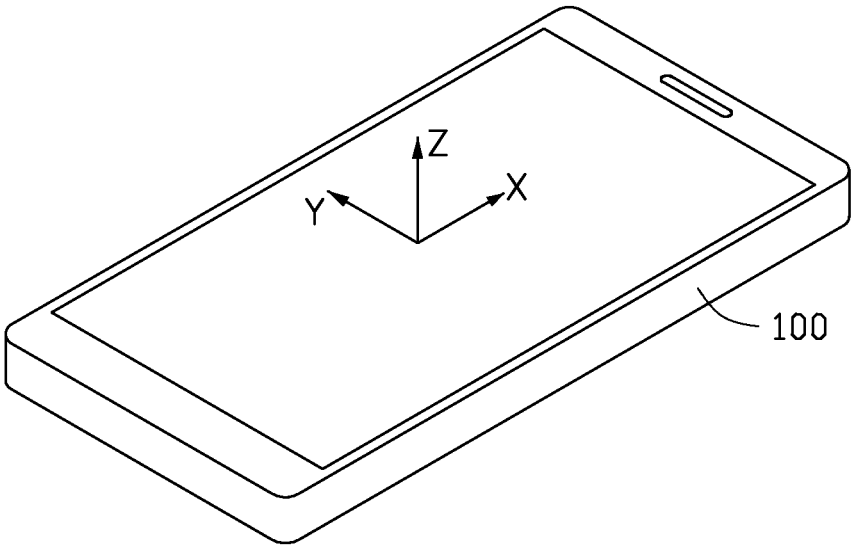


FIG. 2

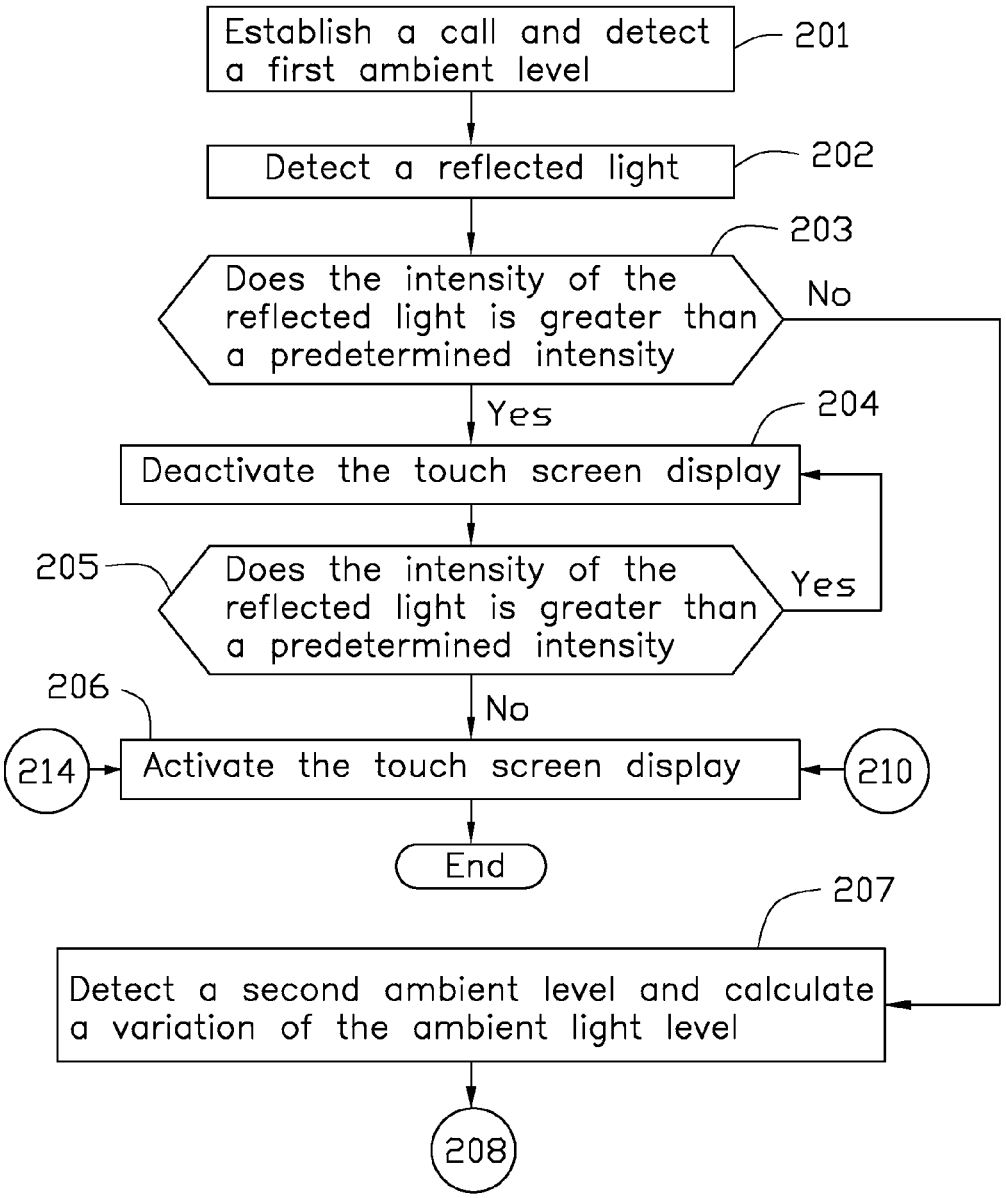

Establish a call and detect a first ambient level
201
Detect a reflected light
202
203
Does the intensity of the reflected light is greater than a predetermined intensity
No
Yes
204
Deactivate the touch screen display
205
Does the intensity of the reflected light is greater than a predetermined intensity
Yes
206
No
214
Activate the touch screen display
210
End
207
Detect a second ambient level and calculate a variation of the ambient light level
208

FIG. 3

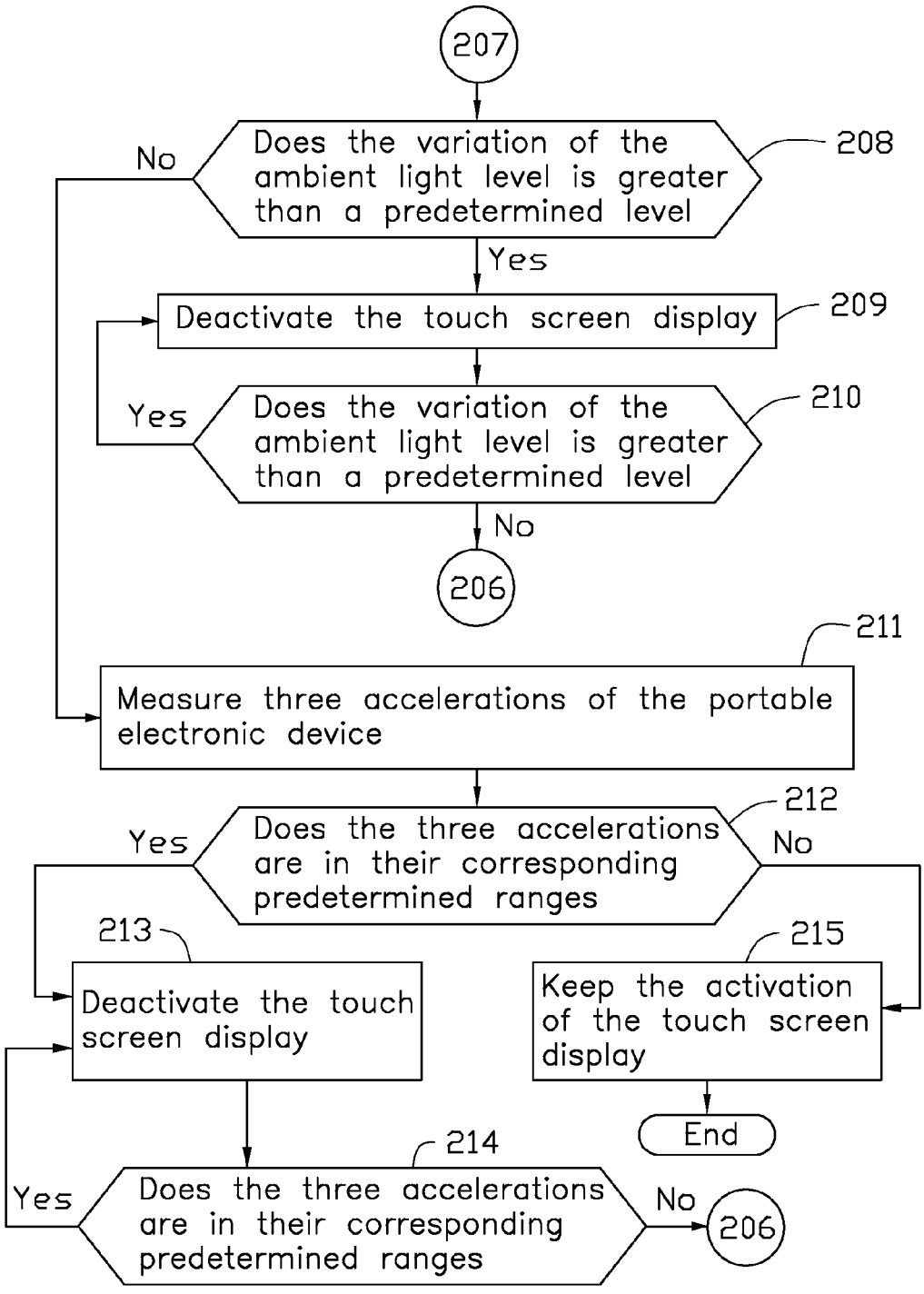

207
Does the variation of the ambient light level is greater than a predetermined level
208
No
Yes
Deactivate the touch screen display
209
Does the variation of the ambient light level is greater than a predetermined level
210
Yes
No
206
211
Measure three accelerations of the portable electronic device
Does the three accelerations are in their corresponding predetermined ranges
212
Yes
No
213
Deactivate the touch screen display
215
Keep the activation of the touch screen display
End
214
Does the three accelerations are in their corresponding predetermined ranges
Yes
No
206

FIG. 4

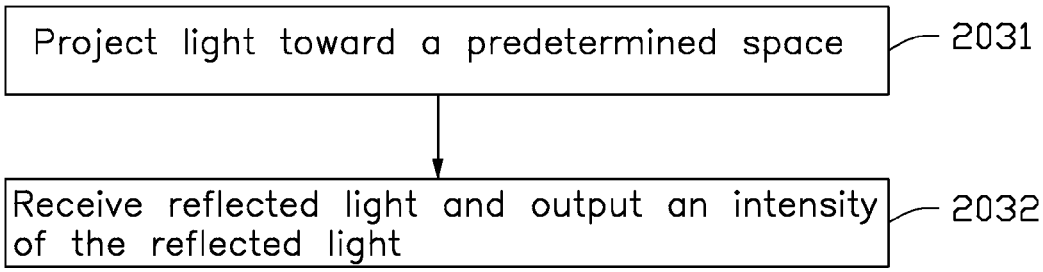

Project light toward a predetermined space
2031
Receive reflected light and output an intensity of the reflected light
2032

FIG. 5

PORTABLE ELECTRONIC DEVICE AND METHOD OPERATING SAME

FIELD

The subject matter herein generally relates to portable electronic devices, and particularly to a portable electronic device having a touch screen display and a method for controlling the touch screen display.

BACKGROUND

An electronic device, such as a cellular telephone, may include a touch screen display and a proximity sensor. The proximity sensor may be used to determine whether the cellular telephone is near a user's head. When not in proximity to the user's head, the cellular telephone may be placed in a normal mode of operation in which the touch screen display is used to present visual information to the user and in which a touch sensor functionality of the touch screen is enabled. In response to determining that the cellular telephone has been brought into the vicinity of the user's head, the display may be disabled to conserve power and the touch sensor on the display may be temporarily disabled to avoid inadvertent touch input from contact between the user's head and the touch sensor.

A proximity sensor for use in a cellular telephone may be based on an infrared light-emitting diode and a corresponding infrared light detector. During operation, the light-emitting diode may emit infrared light outwards from the cellular telephone. When the cellular telephone is not in the vicinity of a user's head, the infrared light will not be reflected towards the light detector and only small amounts of reflected light will be detected by the light detector. When, however, the cellular telephone is adjacent to the user's head, the emitted light from the infrared light-emitting diode will be reflected from the user's head and detected by the light detector.

Light-based proximity sensors such as these may be used to detect the position of a cellular telephone relative to a user's head, but can be challenging to operate accurately. If care is not taken, it can be difficult to determine when a user's head is in the vicinity of the cellular telephone, particularly when a user has hair that is dark colored and exhibits low reflectivity or when the proximity sensor has become smudged with grease from the skin of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

Implementations of the present technology will now be described, by way of example only, with reference to the attached figures.

FIG. **1** is a block diagram of one embodiment of a portable electronic device.

FIG. **2** is an isometric view of the portable electronic device as shown in FIG. **1**.

FIGS. **3-4** are a flowchart of one embodiment of a method for controlling a touch screen display of a portable electronic device.

FIG. **5** is a detailed description of block **202** in FIG. **3**.

DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts have been exaggerated to better illustrate details and features of the present disclosure.

Several definitions that apply throughout this disclosure will now be presented.

The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently connected or releasably connected. The term "comprising" when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the like.

FIG. **1** illustrates a block diagram of one embodiment of a portable electronic device **100** including a proximity sensor **10**, an ambient light sensor **20**, a controller **30**, and a touch screen display **40**. The proximity sensor **10** is configured to determine whether the portable electronic device **100** is in a vicinity of an object, such as a user's head. The ambient light sensor **20** is configured to detect and output a variation of an ambient light level of the portable electronic device **100**. The controller **30** is electronically coupled to both the proximity sensor **10** and the ambient light sensor **20**, and is configured to activate/deactivate the touch screen display **40** according to the determination of the proximity sensor **10** and the variation of the ambient light level detected by the ambient light sensor **20**.

The proximity sensor **10** includes a light-emitting element **11** and a light-receiving element **12**, both of which are electronically coupled to the controller **30**. The light-emitting element **11** projects/emits light toward a predetermined space. The light-receiving element **12** receives reflected light, and outputs an intensity of the reflected light to the controller **30**. For example, the light-receiving element **12** can output a first electric signal to the controller **30** in accordance with the intensity of the reflected light. The reflected light can be obtained when the light projected by the light-emitting element **11** is reflected from an object (such as a user's head) to be detected to which a detection of whether or not the object to be detected comes close to the proximity sensor **10** is carried out. The controller **30** activates/deactivates the touch screen display **40** by comparing the intensity of the reflected light with a predetermined intensity. When the intensity of the reflected light is greater than the predetermined intensity, the controller **30** deactivates the touch screen display **40**. Alternatively, when the intensity of the reflected light is less than the predetermined intensity, the controller **30** further configured to determine whether the variation of the ambient light level is greater than a predetermined level, and deactivate the touch screen display **40** when it is determined by the controller **30** that the variation of the ambient light level is greater than the predetermined level.

For example, when a call is established, the proximity sensor **10** is activated by the controller **30**. If the user holds the portable electronic device **100** adjacent to the user's ear such that the portable electronic device **100** is brought into a vicinity of the user's head, the intensity of the reflected light is greater than the predetermined intensity, the controller **30** deactivates the touch screen display **40** to conserve power and

prevent inadvertent touch input. Alternatively, if the portable electronic device **100** is not brought into (or is absent from) the vicinity of the user's head, the intensity of the reflected light is less than the predetermined intensity, the controller **30** keeps the activation of the touch screen display **40** or activates the touch screen display **40** again. However, when the portable electronic device **100** is brought into a vicinity of the user's head and the user has hair that is dark and exhibits low reflectivity, the intensity of the reflected light may be less than the predetermined intensity. At this time, the controller **30** further compares the variation of the ambient light level with a predetermined level, to determine whether or not the touch screen display **40** should be deactivate.

In one embodiment, when the ambient light sensor **20** detects a first ambient light level when the portable electronic device **100** establishes the call, and detects a second ambient light level when the controller **30** determines that the intensity of the reflected light is less than the predetermined intensity. The variation of the ambient light level is a difference between the first and second ambient light levels. In particular, the first ambient light level is an average value of a plurality of ambient light levels (such as ten ambient light levels) detected by the ambient light sensor **20** within a predetermined time (such as two seconds) after the call is established.

As illustrated in FIG. **1**, the portable electronic device **100** is also provided with an accelerometer **50** electronically coupled to the controller **30**. The accelerometer **50** is configured to measure a tilt angle of the portable electronic device **100** with respect to earth ground plane. The controller **30** is further configured to determine whether the touch screen display **40** should be deactivated according to the slope angle when it is determined by the controller **30** that the variation of the ambient light level is less than the predetermined level.

FIG. **2** illustrates an isometric view of the portable electronic device **100** as shown in FIG. **1**. The tilt angle of the portable electronic device **100** can be defined by three accelerations of the portable electronic device **100** in three directions of X axes, Y axes, and Z axes, which are substantially perpendicular to each other. As shown in FIG. **2**, the Z axes is substantially perpendicular to a plane in which the touch screen display **40** is positioned, the Y axes and X axes are positioned in the plane in which the touch screen display **40** is positioned. In one embodiment, when the acceleration in X axes is in a range from −0.87 g to zero (wherein g is the gravity acceleration, and a value of g is about 9.8), the acceleration in Y axes is in a range from 0.71 g to g, and the acceleration in Z axes is in a range from zero to 0.25 g, the controller **30** deactivates the touch screen display **40**. Alternatively, when any one of the X axes, Y axes, and Z axes is out of its corresponding range, the controller **30** keeps the activation of the touch screen display **40** or activates the touch screen display **40** again.

For example, when the portable electronic device **100** is located on a level plane, such as a surface of table, the accelerations of X axes and Y axes are zero, while the acceleration of the Z axes is about g (9.8). When the call is established and the portable electronic device **100** is held adjacent to the user's ear, the portable electronic device **100** is sloped, and the accelerations of X axes, Y axes, and Z axes are, for example, −0.714 g, 8 g and 1.45 g respectively.

Referring to FIGS. **3-4**, a flow chart is presented in accordance with an example embodiment which is being thus illustrated. The example method **200** is provided by way of example, as there are a variety of ways to carry out the method. The method **200** described below can be carried out using the configurations illustrated in FIGS. **1-2**, for example, and various elements of these figures are referenced in explaining example method **200**. Each block shown in FIG. **3** represents one or more processes, methods or subroutines, carried out in the exemplary method **200**. Additionally, the illustrated order of blocks is by example only and the order of the blocks can change according to the present disclosure. The exemplary method **200** can begin at block **201**.

At block **201**, a call is established by the portable electronic device **100**. The ambient light sensor **20** detects a first ambient level. In one embodiment, the first ambient light level is an average value of a plurality of ambient light levels (such as ten ambient light levels) detected by the ambient light sensor **20** within a predetermined time (such as two seconds) after the call is established.

At block **202**, the proximity sensor **10** detects and output an intensity of a reflected light. Details of detecting an intensity of a reflected light will be described in FIG. **4**.

At block **203**, the controller **30** determines whether the intensity of the reflected light is greater than a predetermined intensity. Upon the condition that the intensity of the reflected light is greater than the predetermined intensity, block **204** is implemented. Otherwise, upon the condition that the intensity of the reflected light is less than the predetermined intensity, block **207** is implemented.

At block **204**, the controller **30** deactivates the touch screen display **40**.

At block **205**, the controller **30** determines whether the intensity of the reflected light is greater than a predetermined intensity. Upon the condition that the intensity of the reflected light is greater than the predetermined intensity, block **204** is implemented. Otherwise, upon the condition that the intensity of the reflected light is less than the predetermined intensity, block **206** is implemented.

At block **206**, the controller **30** activates the touch screen display **40**.

At block **207**, the ambient light sensor **20** detects a second ambient level, and calculates and outputs a variation of the ambient light level to the controller **30**. The variation of the ambient light level is a difference between the first and second ambient light levels.

At block **208**, the controller **30** determines whether the variation of the ambient light level is greater than a predetermined level. Upon the condition that the variation of the ambient light level is greater than the predetermined level, block **209** is implemented. Otherwise, upon the condition that the variation of the ambient light level is greater than the predetermined level, block **211** is implemented.

At block **209**, the controller **30** deactivates the touch screen display **40**.

At block **210**, the controller **30** determines whether the variation of the ambient light level is greater than a predetermined level. Upon the condition that the variation of the ambient light level is greater than the predetermined level, block **209** is implemented. Otherwise, upon the condition that the variation of the ambient light level is greater than the predetermined level, block **206** is implemented.

At block **211**, the controller **30** control the accelerometer **50** to measure three accelerations of the portable electronic device **100** in three directions of X axes, Y axes, and Z axes, which are substantially perpendicular to each other.

At block **212**, the controller **30** determines whether the three accelerations are in their corresponding predetermined ranges. In one embodiment, the predetermined range of the acceleration of the X axes is from about −0.87 g to zero (wherein g is the gravity acceleration, and a value of g is about 9.8), the predetermined range of the acceleration of the Y axes is from 0.71 g to g, and the predetermined range of the

acceleration of the Z axes is from zero to 0.25 g. Upon the condition that the three accelerations are in their corresponding predetermined ranges, block **213** is implemented. Otherwise, upon the condition that any one of the three accelerations is out of its corresponding predetermined range, block **215** is implemented.

At block **213**, the controller **30** deactivates the touch screen display **40**.

At block **214**, the controller **30** determines whether the three accelerations are in their corresponding predetermined ranges. Upon the condition that the three accelerations are in their corresponding predetermined ranges, block **213** is implemented. Otherwise, upon the condition that any one of the three accelerations is out of its corresponding predetermined range, block **206** is implemented.

At block **215**, the controller **30** keeps the activation of the touch screen display **40**.

FIG. **5** is a detailed description of block **202**. Depending on the embodiment, additional blocks may be added, others removed, and the ordering of the blocks may be changed.

At block **2031**, the light-emitting element **11** projects light toward a predetermined space.

At block **2032**, the light-receiving element **12** receives reflected light of the light projected by the light-emitting element **11**, and outputs an intensity of the reflected light.

The embodiments shown and described above are only examples. Many details are often found in the art. Therefore, many such details are neither shown nor described. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, including in matters of shape, size and arrangement of the parts within the principles of the present disclosure up to, and including the full extent established by the broad general meaning of the terms used in the claims. It will therefore be appreciated that the embodiments described above may be modified within the scope of the claims.

What is claimed is:

1. A portable electronic device comprising:

a touch screen display;

a proximity sensor comprising a light-emitting element and a light-receiving element, the light-emitting element configured to project light toward a predetermined space, the light-receiving element configured to receive reflected light and output an intensity of the reflected light;

an ambient light sensor configured to detect and output a variation of an ambient light level of the portable electronic device; and

a controller electronically coupled to both the light-receiving element and the ambient light sensor to receive the intensity of the reflected light and the variation of the ambient light level, the controller configured to deactivate the touch screen display when it is determined by the controller that the intensity of the reflected light is greater than a predetermined intensity, and determine whether the variation of the ambient light level is greater than a predetermined level when it is determined by the controller that the intensity of the reflected light is less than the predetermined intensity; the controller further configured to deactivate the touch screen display when it is determined by the controller that the variation of the ambient light level is greater than the predetermined level;

wherein the ambient light sensor is configured to detect a first ambient light level when the portable electronic device establishes a call, and the first ambient light level is an average value of a plurality of ambient light levels detected by the ambient light sensor within a predetermined time after the call is established.

2. The portable electronic device of claim **1**, wherein the ambient light sensor is further configured to detect a second ambient light level when the controller determines that the intensity of the reflected light is less than the predetermined intensity, and the variation of the ambient light level is a difference between the first and second ambient light levels.

3. The portable electronic device of claim **1**, further comprising an accelerometer electronically coupled to the controller, and configured to measure a tilt angle of the portable electronic device with respect to earth ground plane, wherein the controller is configured to either activate or deactivate the touch screen display according to the slope angle when it is determined by the controller that the variation of the ambient light level is less than the predetermined level.

4. The portable electronic device of claim **3**, wherein the tilt angle is defined by three accelerations of the portable electronic device in three directions of first axes, second axes, and third axes, which are substantially perpendicular to each other, the third axes is substantially perpendicular to a plane in which the touch screen display is positioned, the second axes and first axes are positioned in the plane in which the touch screen display is positioned; when the acceleration in first axes is in a range from −0.87 g to zero, the acceleration in second axes is in a range from 0.71 g to g, and the acceleration in third axes is in a range from zero to 0.25 g, the controller deactivates the touch screen display; wherein g is the gravity acceleration.

5. A method of control a touch screen display of a portable electronic device, comprising:

projecting light toward a predetermined space when the portable electronic device establish a call;

receiving reflected light and outputting an intensity of the reflected light;

determining whether the intensity of the reflected light is greater than a predetermined intensity;

detecting a variation of an ambient light level of the portable electronic device upon the condition that the intensity of the reflected light is less than the predetermined intensity;

determining whether the variation of the ambient light level is greater than a predetermined level; and

deactivating the touch screen display upon the condition that the variation of the ambient light level is greater than the predetermined level;

wherein the step of detecting a variation of an ambient light level of the portable electronic device comprises:

detecting a first ambient light level when the portable electronic device establishes a call, wherein the first ambient light level is an average value of a plurality of ambient light levels detected by the ambient light sensor within a predetermined time after the call is established.

6. The method of claim **5**, wherein the step of detecting a variation of an ambient light level of the portable electronic device further comprising:

detecting a second ambient light level upon the condition that the intensity of the reflected light is less than the predetermined intensity; and

calculating and outputting a difference between the first and second ambient light levels.

7. The method of claim 5, further comprising:

measuring three accelerations of the portable electronic device in three directions of a first axes, a second axes, and a third axes which are substantially perpendicular to each other, upon the condition that the variation of the ambient light level is less than the predetermined level;

determining whether the three accelerations are in their corresponding predetermined ranges; and

deactivating the touch screen display upon the condition that the three accelerations are in their corresponding predetermined ranges.

8. The method of claim 7, wherein the third axes is substantially perpendicular to a plane in which the touch screen display is positioned, the second axes and first axes are positioned in the plane in which the touch screen display is positioned, the predetermined range of the acceleration of the X axes is from about −0.87 g to zero, the predetermined range of the acceleration of the Y axes is from 0.71 g to g, and the predetermined range of the acceleration of the Z axes is from zero to 0.25 g; g is the gravity acceleration.

* * * * *